EFFECTS OF DIFFERENT RECOVERY METHODS ON HANGBOARD PERFORMANCE IN ROCK CLIMBERS: A PILOT STUDY

By Daniel Ehrich

A Thesis Presented in Partial Fulfillment Of the Requirements for the Degree Master of Science in Human Performance: Strength and Conditioning

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Effects of Different Recovery Methods on Hangboard Performance in Rock Climbers: A Pilot Study

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Abstract

Ehrich, Daniel; Hornsby, Jared; Bosak, Andy. Effects of Different Recovery Methods on Hangboard Performance in Rock Climbers: A Pilot Study. Liberty University. The purpose of this study was to determine whether static stretching, dynamic shakes, or repeated contractions would promote the greatest retention in performance in hangboard training within a given period of time. Five volunteer intermediate climbers from the Liberty University rock climbing team were instructed to suspend themselves from a 20mm ledge on a hangboard until voluntary failure while time was recorded. After failure, subjects performed one of three different recovery methods and a control in randomized order for two minutes in alternating fifteen-second intervals. Upon finishing recovery, subjects would hang from the same ledge and have their time recorded again. All subjects performed all recovery methods over the course of the semester. A multi variant repeated-measures ANOVA and one-way ANOVA compared total time of hang before and after between groups and hang time Δ between groups respectively. Unfortunately, statistical power was too weak to find any significant differences between groups ($p=1$). Significant differences were found between pre and post-hang times ($p<0.001$) with subjects hanging 5.2 seconds longer on average during the first hang. The study should be repeated with modifications to the study population, these being: open the study to climbers outside the team and its staff, increase the amount of experience needed, and have a pre-test to ensure climbers can hang for at least twenty seconds.

Introduction

Over the past few years, rock climbing has greatly increased in popularity ([1,2,3]). What was formerly a niche sport has been brought to the greater public's attention through Oscar winning films ([3]) and inclusion in the upcoming Olympics ([4]). Despite this increase in attention, the training methodology for maximum performance in rock climbing is still in development, with many methods being proposed for various climbing disciplines ([5,6,7]). Common limiting factors in all forms of rock climbing are forearm strength ([8,9,10,11]) and how quickly athletes can recover from climbs ([11,12,13,14]). Climbers train both of these aspects of their performance using hangboards, narrow ledges of various depths that allow climbers to safely progressively overload their forearm strength ([15,16,17]). When performing this type of training, and other forms of rock climbing training, different methods to recovery between sets have been proposed ([6,7,15,16,17,18]). Some of the commonly used forms of recovery between climbing attempts are: static stretching of the

forearms by pulling the hand backward towards the arm, dynamic shaking of the arms and hands, and repeated contractions where the climber will open and close their hand in an effort to move metabolic byproducts products out of the forearm muscle ([7,8]). While the effectiveness of these recovery methods on strength and endurance have been tested in other disciplines ([19,20,21,22,23,24,25,26]), their effectiveness in rock climbing training is mostly anecdotal. In addition, the amount of time needed for recovery is still being elucidated, with different studies proposing different times between climbs ([8,9,27]), Lastly, the ability to go to failure safely in these forms of training is of utmost importance ([28]). After examining these studies and seeing a lack of data on commonly used methods, it became clear that the purpose of this study was to determine whether static stretching, dynamic shakes, or repeated contractions would promote the greatest retention in performance in hangboard training within a given period of time.

Methods

This study took place during the COVID-19 pandemic, so for the duration of the study, all participants wore facemasks and used hand sanitizer prior to using the hangboard. Before the study began, all athletes were informed of potential risks and signed informed consent waivers. Subjects included 3 males and 2 females from the Liberty University rock climbing team. Subjects had no prior injuries and were able to climb at least V4 routes; these are intermediate routes and ensured that climbers would not have any learned effect during the course of the study. Subjects were instructed to not climb prior to data collection on the days of the study. The subjects were randomly assigned an order in which they would do three different recovery methods and a control; these were counter-balanced to ensure no learned effect occurred over the course of the study. No verbal encouragement was given during the study and subjects were not given their results until after all the data were collected. The subjects completed an informed consent form prior to any data being collected and the study was approved by Liberty University's Institutional Review Board.

Procedures

Before trials, athletes would perform the same warm up they would do before practice. This consisted of: two sets of ten birddogs for each side; ten side plank reach throughs per side; thirty deep squat water flicks, rapidly opening and closing hands with arms upward while in a deep squat position; traversing the rock wall, approximately forty meters, at the climbers own pace, selecting their preferred hand and footholds; three sets of I,Y,T shoulder pull-aparts using TRX straps, and ten second pronated grip bar hangs with arms at ninety and one hundred and twenty degrees. After the warm-up, each subject would approach the wooden hangboard and grip the 20mm ledge. Chalk was allowed on the hands to prevent sweat and oil buildup on the hands and ledge, which could decrease performance. Once they were ready, the subject would begin the hang by bending their knees backward so their whole body would be suspended or by stepping off a small platform. A recorder with a stopwatch would record the total time the subject was hanging. The subject would hang until voluntary failure defined as when the subject let

go of the ledge. The timer would stop and record the value at this point. Immediately after voluntary failure, the subject would perform their assigned recovery method for the session. All subjects were given 2 minutes to recover. For all but the control, the 2 minutes consisted of alternating 15 seconds of the assigned recovery and standing still. These consisted of: standing for the control, static stretching by putting the hands together, palms touching, and then inverting them so the fingers pointed downward; repeated contractions, where the subject opened and closed their hands at their own pace, usually between 1-2 contractions per second, and dynamic shakes, consisting of moderately shaking their arms at their side. After completing the assigned recovery method, the subject went back to the ledge and hung until voluntary failure again with their time being recorded in the same manner as the first hang. Subjects had at least 48 hours of recovery between testing sessions. This was done until all subjects had competed all recovery methods.

Statistical Analysis

Using SPSS software, mean and standard deviation were calculated for each method of recovery. A 2x4 multi variant repeated measures ANOVA ($\alpha<0.05$) and a one-way ANOVA ($\alpha<0.05$) compared pre/post hang times between the groups and hang time Δ between groups respectively. Microsoft Excel was used to calculate effect size using Cohen's D based on respective means and pooled standard deviations.

Results

Tables 1-4 are from the multi variant repeated-measures ANOVA that compared total time of hang before and after between groups. The power of this statistic was 0.069, too weak to elucidate any statistical differences between groups ($p=1$). However there were significant differences between pre and post hang times ($p<0.001$) Effect size was also measured, but no significant differences were found. Tables 5-7 are from the one-way ANOVA that compared the hang time Δ between groups. Cohen's D was used to measure effect size between groups from both statistical tests. None reached the threshold of small difference (Tables 4,7).

Table 1- Descriptive statistics for recovery methods, it was used to calculate effect size.

Descriptive Statistics

	Group	Mean	Std. Deviation	N
Pre	Control	33.716	16.92211	5
	Dynamic	32.704	16.68073	5
	CR	30.15	14.33068	5
	Static	28.922	13.26094	5
	Total	31.373	14.24803	20
Post	Control	28.332	15.02248	5
	Dynamic	27.944	13.05384	5
	CR	25.05	13.1724	5
	Static	23.344	10.89564	5
	Total	26.1675	12.22278	20

Table 2- Pairwise comparison between the different recovery methods; none of the groups were significantly different from the other.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.[a]
Control	Dynamic	0.7	8.939	1
	CR	3.424	8.939	1
	Static	4.891	8.939	1
Dynamic	Control	-0.7	8.939	1
	CR	2.724	8.939	1
	Static	4.191	8.939	1
CR	Control	-3.424	8.939	1
	Dynamic	-2.724	8.939	1
	Static	1.467	8.939	1
Static	Control	-4.891	8.939	1
	Dynamic	-4.191	8.939	1
	CR	-1.467	8.939	1

Table 3- Pairwise comparison between first and second hang. Second hang was significantly shorter than first across all groups.

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]
1	2	5.206*	0.951	0
2	1	-5.206*	0.951	0

Table 4- Values of effect sizes between recovery methods.

Cohen's D					
CxD	0.003	CxRC	0.003	CxS	0.002
DxRC	0.000	DxS	-0.002		
RCxS	-0.002				

C: Control D: Dynamic Shakes RC: Repeated Contractions S: Static Stretch

Table 5-Descriptive statistics for recovery method hang time Δ, used to calculate effect size.

	N	Mean	Std. Deviation
1	5	5.384	4.77066
2	5	4.76	3.83837
3	5	5.1	4.01683
4	5	5.578	4.3298
Total	20	5.2055	3.91622

1: Control 2: Dynamic Shakes 3: Repeated Contractions 4: Static Stretch

Table 6- Pairwise comparison between the different recovery method Δ; none of the groups were significantly different from the other.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
1	2	0.624	2.69025	1
	3	0.284	2.69025	1
	4	-0.194	2.69025	1
2	1	-0.624	2.69025	1
	3	-0.34	2.69025	1
	4	-0.818	2.69025	1
3	1	-0.284	2.69025	1
	2	0.34	2.69025	1
	4	-0.478	2.69025	1
4	1	0.194	2.69025	1
	2	0.818	2.69025	1
	3	0.478	2.69025	1

1: Control 2: Dynamic Shakes 3: Repeated Contractions 4: Static Stretch

Table 7- Values of effect sizes between recovery method Δ's.

Cohen's D					
CxD	0.017	CxRC	0.007	CxS	-0.005
DxRC	-0.011	DxS	-0.024		
SxRC	-0.014				

C: Control D: Dynamic Shakes RC: Repeated Contractions S: Static Stretch

Discussion

The purpose of the study was to determine whether static stretching, dynamic stretching or repeated contractions, would promote the greatest retention in performance in hangboard training within a given period of time.

Multiple presentations were given at different practices to recruit additional climbers but only seven climbers initially volunteered for the study, after which two dropped out due to medical problems that occurred outside the study. The Covid-19 pandemic greatly reduced the amount of athletes on the team this semester and shut down other teams entirely. A confluence of uncontrollable circumstances made finding enough subjects to produce a statistically valid study impossible given the study's limitations. In order to get

more subjects, the population of the study should be both expanded and be more selective. First, open the study up to climbers outside the team and its staff, and second increase the amount of experience needed to reduce variance in the population, a pre-test to ensure climbers can hang for at least twenty seconds would be greatly recommended. In this study, one climber would hang for an average of ten seconds and another, for over fifty seconds. By reducing variance between subjects, variance between recovery methods could be easier to distinguish; this was done by Watts et al. ([9]) with the same sample size as this study.

Repeated-measures ANOVA was not able to find a statistical difference between groups, neither could a one-way ANOVA. Significant differences were found between pre and post-hang times with climbers on average able to hang 5.2 seconds longer during the initial hang. However, climbers did have preferences. In conversation, climbers mentioned that the control felt unusual and they performed some kind of recovery on their own training. The repeated contraction was not well received as climbers complained about excessive muscle pump and fatigue after this method. Dynamic shakes and static stretch were well received and subjects reported using these when training on their own.

When compared to other studies, the potential information to be gained from a full study on this subject would compliment other studies. When using climbing routes as a method of fatigue, Valenzuela et al. ([6]) and Heyman et al, ([7]) found active recovery, low intensity climbing, to preferred passive recovery (walking). This study looked into substituting easy climbing with repeated contractions since hangboards are more common than full rock walls and hand contractions could be an alternative during home training. Heyman et al. ([7]) used unorthodox recoveries such as cold-water immersion and electrical stimulation, neither of which is easily accessible in rock climbing gyms or outdoors. In contrast, this study compares methods already used by climbers and could drastically decrease recovery times. Recovery time is a major limiting factor of training. Both Draper et al. ([18]) and Watts et al. ([9]) found that extensive rest times are needed for full recovery, more than 4 minutes for short climbs, defined as under two minutes, and more than 20 minutes after voluntary failure. Climbers want to maximize training in a given time period, especially in these pandemic times where most climbing gyms have limited time blocks so an easy way to cut down required rest would be very desirable.

Practical Applications

In conclusion, with only five test subjects, it is not possible to draw any definitive performance recommendations other than two minutes is not enough time for full recovery and this was supported by other studies ([6,7,8,9,18]). No recovery method can be confidently recommended because of the low power of this study (.069); neither can any be discounted for statistical reasons. At the moment, it appears that personal preference is the main deciding factor for how climbers should recover between climbs.

Future research should start with performing this study with the aforementioned population modifications. From there, studies should focus on combining the best

performing methods to see if they work synergistically. Additionally, future studies can implement repeated boulder problems or top rope climbs as the source of fatigue instead of hangboard duration.

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I would like to thank Liberty University for allowing me to use their rock climbing gym and Dr. Bosak, for lots of patience and assistance as we tried to salvage what we could from this study and Dr. Hornsby, who provided essential statistical assistance in an effort to find something significant in these data. Additionally, the staff and members of the rock climbing team at Liberty University have my thanks; your input and discussions about this subject gave me some really good questions that we can hopefully answer in the future.

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